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AUSTRALITES FROM NNE. OF MORGAN, SOUTH AUSTRALIA

By George Baker

Introduction

From an area of approximately one mile in extent, situated 16 miles NNE. of Morgan, South Australia, 148 australites were collected by the late Mr Benjamin Thamm and Mrs Doris Thamm between 1924 and 1928. The specimens were made available for study by Mrs Thamm in 1964 through the courtesy of Mr R. Seeger, and are said to be representative of the australites occurring in this area. They are now registered as numbers E3965-E3992, E3994-E4113 in the National Museum of Victoria.

The specimens were discovered on relatively bare areas in flat grazing country where some soil deflation had occurred, and were exposed at the surface of the ground on patches of hardened sandy soil with associated light-brown and brownish-red to red loam. The most fruitful searching periods are reported by Mrs Thamm to have been in dry windy weather. Specimens were located during relatively frequent traverses across the bared areas, and usually occurred with the anterior surface facing upwards. The author is indebted to Mrs Thamm and her brother, Mr Waldron, for information relating to the specimens.

Morgan is situated at the junction of Burra Creek and the Murray River, on the 'Northwest Bend' of the Murray, at approximately 140°E. and 33°30′S., 90-100 miles NE. of Adelaide. The soils from which the australites were released occur on Tertiary sediments that form part of an inland basin.

Australites subjected to a comparable degree of weathering and with different proportions of shape types were found between 1936 and 1940 in this general region at Florieton on Burra Creek some 20 miles NW. of Morgan (Mawson 1958) where they occurred under similar conditions, the areas being soil-deflated patches in a semi-arid region originally cleared and ploughed for growing wheat and later utilized for sheep grazing.

Two other specimens included with the Thamm collection of australites are black in colour, dense in texture, but not glassy like the australites; they resemble black lydianstone. One is small, rounded, sub-spherical and measures 5 mm × 4·5 mm × 3·5 mm. The other is larger, elongated, and is a ventifact with four facets cut and shaped by windblown sand. One facet is larger and one smaller than two of intermediate size, and the specimen measures 38 mm × 10·5 mm × 9·5 mm. Stones of this size, shape and colour have frequently been mistaken for australites.

Dimensions, weights and specific gravity values

The dimensions, weights and specific gravity values of the 148 australites constituting the Thamm collection are set out in Table 1. The specific gravity values were determined by weighing each thoroughly cleaned specimen in air and deionized water (T = 18°C.) on an air-damped chemical balance. Ranges in values and average values for these properties are brought together in summarized form in Table 2. The least weight of 0·314 gms (Table 1, 120) was for a small oval (Pl. 10, fig. 34), and the greatest weight of 72·349 gms (Table 1, 1) for a large core (Pl. 10, fig. 2). The lowest specific gravity (Table 1, 98) was for a large teardrop

(Pl. 12, fig. 27), and the highest (Table 1, 132) for a canoe-shaped-shaped form (Pl. 11, fig. 32-34). From the specific gravity-silica content relationships of tektites (Baker 1959a, Fig. 13), the range in specific gravity of the Morgan australites points to a range in silica content of 71·5% to 79·5%, with an average of 74·5%.

The frequency distribution of the 148 specific gravity determinations is given in figure 1.

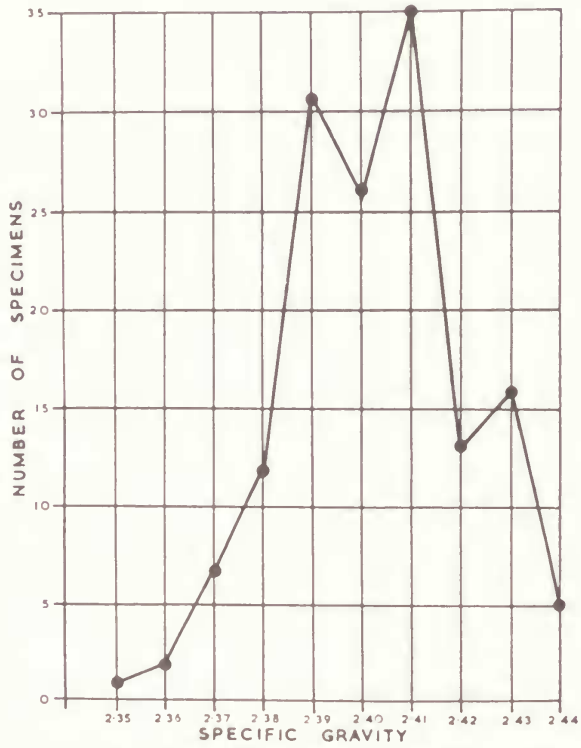

FIG. 1—Frequency polygon showing distribution of specific gravity values for 148 australites from near Morgan, South Australia. The arithmetic mean of the specific gravity values is 2·405.

In as much as the silica content of australites varies inversely as the specific gravity, with the lower specific gravity values indicating glass rather richer in SiO_2, the average values for the specific gravity of the various shape types shown in Table 2 point to the groups of the lenses, boats, teardrops and most of the dumbbells being rather more acidic than the groups of the round cores, ovals and canoes. This contrasts with the australite shape types from Mulka, where the average specific gravity values indicate that most ovals, canoes and teardrops are rather more acidic than the lenses, boats, dumbbells and round cores (Baker, in press). Since average values are under consideration, the variations shown are more likely due to chemical variations than to changes in small gas bubble contents from shape group to shape group.

Comparison of australite shape type percentages and weights from near Morgan, from Florieton, and from Mulka, S.A.

On the grounds that the numbers of specimens classifiable into specific shape types for the australites from the Morgan district and from Florieton respectively

TABLE 1

Dimensions, weights and specific gravity values of 148 australites from Morgan, S.A.

	Collection Number	Shape Type	Diameter (mm)	Depth (mm)	Length (mm)	Width (mm)	Flange width (mm)	Weight (gms)	Sp. gr.
4 Buttons (2·7% total)	111	Flanged button (round in plan)	20·2	9·0			2·6	3·349	2·403
	117		14·9	6·6				1·588	2·389
	119		12·6	6·0				1·027	2·410
		Average	15·9	7·2				1·288	2·401
	112	Hollow button (broken)	22·5 (ex-flange)	10·6+ (back surface broken)				4·045	2·411
2 Lenses (1·3%)	116	Lens	16·9	7·4				2·275	2·400
	138	Lens	16·4	8·2				2·212	2·392
		Average	16·7	7·8				2·234	2·396
44 Round cores (29·7%)	2	Round core	36·5	24·8				39·671	2·393
	4	,, ,,	34·2	27·8				41·831	2·409
	5	,, ,,	32·0	26·1				33·981	2·413
	6	,, ,,	32·4	24·2				34·137	2·430
	8	,, ,,	24·3	19·2				12·481	2·383
	9	,, ,,	23·5	21·4				15·312	2·424
	10	,, ,,	24·7	17·5				13·426	2·422
	11	,, ,,	24·7	16·5				12·253	2·413
	12	,, ,,	23·4	18·6				11·995	2·405
	13	,, ,,	23·2	17·3				11·371	2·419
	14	,, ,,	24·0	16·0				9·531	2·388
	15	,, ,,	21·8	17·8				10·088	2·411
	16	,, ,,	22·4	16·1				8·690	2·370
	17	,, ,,	21·5	14·6				8·329	2·413
	18	,, ,,	20·2	18·7				9·945	2·406
	19	,, ,,	20·8	16·2				9·501	2·417
	20	,, ,,	21·0	17·1				9·371	2·435
	21	,, ,,	20·9	16·4				8·846	2·410
	22	,, ,,	20·4	16·2				9·172	2·428
	23	,, ,,	20·1	15·1				7·430	2·414
	24	,, ,,	22·0	13·9				8·135	2·405

TABLE 1 (*continued*)

	Collection Number	Shape Type	Diameter (mm)	Depth (mm)	Length (mm)	Width (mm)	Flange width (mm)	Weight (gms)	Sp. gr.
44 Round cores (29·7%) (continued)	25	,, ,,	21·7	15·3				8·788	2·412
	26	,, ,,	22·9	13·0				8·525	2·414
	27	,, ,,	21·4	12·3				7·556	2·436
	28	,, ,,	19·6	12·8				6·507	2·424
	29	,, ,,	20·5	15·3				6·191	2·369
	30	,, ,,	18·9	12·8				5·213	2·396
	31	,, ,,	19·2	11·7				5·451	2·392
	32	,, ,,	19·2	12·3				5·505	2·405
	33	,, ,,	16·6	15·5				6·583	2·429
	35	,, ,,	20·0	13·3				5·453	2·410
	36	,, ,,	19·6	13·3				5·601	2·393
	37	,, ,,	16·9	13·9				4·242	2·404
	38	,, ,,	18·0	10·0				3·722	2·428
	39	,, ,,	16·9	11·0				3·831	2·432
	40	,, ,,	17·5	10·4				3·470	2·401
	41	,, ,,	16·0	12·0				3·689	2·406
	42	,, ,,	15·0	10·8				2·580	2·400
	43	,, ,,	17·8	11·8				4·500	2·414
	44	,, ,,	31·9	25·0				27·020	2·391
	45	,, ,,	30·3	22·8				32·279	2·383
	46	,, ,,	28·5	20·0				20·383	2·409
	47	,, ,,	27·0	18·7				15·300	2·393
	145	,, ,, (broken)	25·0	20·2				(6·689+)	2·390
		Range	15·0 to 36·5	10·0 to 27·8 16·5				2·580 to 41·831 12·041 (43 specimens)	2·369 to 2·436 2·408
		Average	22·6		( ) not included in average				
16 Ovals (10·8%)	48	Oval (broad)		17·9	39·3	31·9		28·808	2·403
	49	,, (broad)		18·5	35·6	28·2		22·604	2·402
	50	,,		15·1	30·5	22·2		12·155	2·396
	51	,,		13·5	28·8	24·0		10·849	2·396
	52	,,		12·9	28·6	20·1		9·474	2·428
	53	,,		13·0	27·8	22·9		9·365	2·380
	54	,, (broad)		11·7	26·3	20·4		7·792	2·391
	57	,,		10·3	23·9	17·9		5·727	2·428

TABLE 1 (*continued*)

	Collection Number	Shape Type	Diameter (mm)	Depth (mm)	Length (mm)	Width (mm)	Flange width (mm)	Weight (gms)	Sp. gr.
		Range		7·9 to 28·4	16·8 to 46·4	13·9 to 44·5		2·550 to 72·349	2·370 to 2·427
		Average		14·5	24·2	20·8		12·556	2·404
18 Boats (12·2%)	69	Boat		7·3	23·2	12·3		2·599	2·391
	70	,,		8·2	21·6	11·6		2·450	2·387
	71	,,		6·2	23·9	14·2		2·809	2·393
	72	,,		6·0	19·5	14·3		1·818	2·405
	73	,,		5·0	22·8	14·1		1·447	2·396
	74	,, (canoe-like in one aspect)		5·8	21·2	8·9		1·310	2·390
	75	,,		5·8	20·2	10·3		1·500	2·384
	76	,,		7·3	24·1	10·6		2·302	2·431
	77	,, (small)		5·2	15·1	10·5		0·772	2·393
	79	,,		9·9	31·6	12·9		5·268	2·397
	80	,,		7·5	30·2	12·1		3·662	2·394
	82	,,		7·6	29·1	13·2		3·689	2·396
	83	,,		8·9	26·7	15·0		4·416	2·393
	86	,,		8·5	22·0	14·9		3·124	2·409
	89	,,		9·7	22·8	15·5		4·183	2·381
	90	,,		13·8	39·2	19·0		12·236	2·404
	115	,,		7·1	23·0	16·0		2·300	2·385
	133	Boat		6·7	20·0	13·3		2·204	2·379
		Range		5·0 to 13·8	15·1 to 39·2	8·9 to 19·0	(2·3)[1]	0·772 to 12·236	2·379 to 2·431
		Average		7·0	23·1	13·3	(2·3)[1]	3·233	2·395
7 Boat cores (4·7%)	55	Boat core		12·3	33·9	19·9		9·557	2·406
	56	,, ,,		10·9	27·5	17·6		6·227	2·376
	58	,, ,,		11·0	29·7	18·1		7·168	2·411
	81	,, ,,		9·7	29·4	12·9		4·587	2·386
	85	,, ,,		10·1	22·0	14·2		3·415	2·379
	96	,, ,,		8·9	39·7	11·7		5·866	2·429
	146	,, ,, (broken)		15·7	(22·0; orig. 30-35)	17·7		(6·689)[2]	2·390

TABLE 1 (*continued*)

	Collection Number	Shape Type	Diameter (mm)	Depth (mm)	Length (mm)	Width (mm)	Flange width (mm)	Weight (gms)	Sp. gr.
		Range		8·9 to 15·7	22·0 to 39·7	11·7 to 19·9		3·415 to 9·557	2·376 to 2·429
		Average		11·2	30·4	16·0		6·137	2·397
	132	Canoe		7·8	22·8	11·4		2·040	2·437
11 Dumbbells (7·5%)	60	Dumbbell		7·8-G 5·5-W	40·2	11·5-G 8·1-W		4·341	2·408
	61	,,		8·8-G 5·8-W	36·9	12·0-G 7·6-W			
	62	,,		6·0 and 6·2-G	40·0	10·4-G 6·0-W	1·5	4·312	2·418
	63	,,		2·5-W 6·7 and 7·5-G	31·2	9·8 and 10·2-G 8·7-W		2·650 2·945	2·374 2·407
	64	,,		5·5-W 6·2-G 4·6-W	32·9	9·8-G 8·1-W 10·8-G		2·606	2·392
	65	,,		6·5-G 5·0-W	33·6	8·0-W 12·0 and		2·818	2·404
	104	,,		8·3 and 9·3-G	30·5	12·5-G 11·1-W		4·669	2·393
	105	,,		7·7-W 6·8-G	26·2	10·7-G 9·7-W		2·463	2·422
	106	,,		6·1-W 5·1 and	24·4	9·0 and 9·2-G		1·651	2·407
	107	,,		5·2-G 6·6-G	25·8	7·5-W 11·2-G		2·471	2·389
	108	,,		5·9-W 5·0 and 5·2-G 4·6-W	21·0	10·2-W 8·2 and 8·9-G 7·6-W		1·182	
		Range		5·0 to 9·3-G		8·2 to 12·5-G		1·182 to 4·341	2·370 to 2·422
				2·5 to 7·7-W	21·0 to 40·2	6·0 to 11·1-W			
		Average		6·8-G 5·3-W	31·2	10·6-G 8·5-W		2·901	2·399

TABLE 1 (*continued*)

	Collection Number	Shape Type	Diameter (mm)	Depth (mm)	Length (mm)	Width (mm)	Flange width (mm)	Weight (gms)	Sp. gr.
4 Dumbbell cores (2·7%)	66	Dumbbell core		9·3 and 9·8-G 8·1-W	47·0	13·1-G 10·8-W		7·731	2·435
	67	" "		12·8-G 11·4-W	49·0	15·2-G 14·0-W		13·644	2·388
	68	" "		9·0 and 9·5-G 8·6-W	36·1	12·2-G 11·3-W		5·414	2·415
	78	" "		7·9 and 9·4-G 7·2-W	42·8	13·4- 13·9-G 12·0-W		7·012	2·390
		Range		7·9 to 12·8-G 7·2 to 11·4-W	36·1 to 49·0	12·2 to 15·2-G 10·8 to 14·0-W		5·414 to 13·644	2·388 to 2·435
		Average		10·0-G 8·8-W	43·7	13·5-G 12·0-W		8·450	2·407
5 Peanut-like Dumbbells (3·4%)	91	'Pea-nut'-like dumbbell (rounded ends)		11·2	38·8	12·6		8·223	2·397
	92	" " (rounded ends)		11·3	39·7	12·2		7·721	2·434
	93	" " (rounded ends)		10·5	34·3	11·2		6·316	2·421
	94	" "		10·3	31·1	11·9		4·857	2·376
	103*	" " (pointed ends)		8·1 to 8·5*	28·5	9·7 to 10·6*		3·147	2·374
		Range		8·1 to 11·3	28·5 to 39·7	9·7 to 12·6		3·147 to 8·223	2·374 to 2·434
		Average		10·3	34·5	11·8		6·053	2·400

TABLE 1 (*continued*)

	Collection Number	Shape Type	Diameter (mm)	Depth (mm)	Length (mm)	Width (mm)	Flange width (mm)	Weight (gms)	Sp. gr.
16 Ovals (10·8%)	59	,,		11·2	25·2	18·2		5·723	2·412
	87	,,		13·5	22·7	17·2		5·324	2·382
	88	,,		11·7	21·5	15·7		4·365	2·427
	118	,, (small)		4·0	13·2	11·2		0·733	2·427
	120	,, (small, plus bubble crater)		3·2	9·3	8·6		0·314	2·429
	121	Oval (small)		6·0	12·4	11·7		0·975	2·397
	122	,, (small 'pip-like')		5·6	11·1	8·2		0·521	2·393
	131	Oval		9·5	16·8	14·0		2·171	2·401
		Range		3·2 to 18·5	9·3 to 39·3	8·2 to 31·9		0·314 to 28·808	2·380 to 2·429
		Average		11·7	23·3	18·3		7·931	2·406
17 Oval cores (11·5%)	1	Oval core		28·4	46·4	44·5		72·349	2·380
	3	,, ,,		23·8	37·5	35·0		39·691	2·393
	7	,, ,,		21·8	33·0	31·0		27·077	2·400
	34	,, ,,		11·9	20·7	18·8		5·823	2·407
	84	,, ,,		10·9	24·3	20·4		5·868	2·408
	124	,, ,, (conical)		10·8	18·7	17·1		4·793	2·425
	125	,, ,, (conical)		10·6	19·2	15·8		3·363	2·397
	126	,, ,,		10·8	18·7	17·1		4·793	2·425
	128	,, ,,		11·2	16·8	15·5		3·173	2·421
	129	,, ,, (conical)		9·3	21·4	16·9		3·670	2·402
	130			7·9	19·6	13·9		2·550	2·388
	139	,, ,,		15·2	21·5	18·5		7 662	2·417
	140	,, ,,		12·9	26·5	20·5		8·232	2·427
	141	,, ,,		17·9	24·3	20·0		8·284	2·389
	142	Oval core (conical)		16·2	22·2	15·2		5·853	2·397
	143	,, ,,		14·7	22·5	16·0		5·705	2·370
	144	,, ,,		12·5	18·9	16·8		4·574	2·417

TABLE 1 (*continued*)

	Collection Number	Shape Type	Diameter (mm)	Depth (mm)	Length (mm)	Width (mm)	Flange width (mm)	Weight (gms)	Sp. gr.
Oval 'nut-like' form (0·7%)	95	Oval 'nut-like' form		12·2	22·0	13·4		4·809	2·411
16 Teardrops (10·8%)	97	Teardrop		9·2	24·5	13·2		2·945	2·407
	98	„		11·3	22·8	15·4		3·681	2·348
	99	„		10·2	20·8	15·1		3·255	2·393
	100	„		11·0	23·4	13·5		2·894	2·358
	101	„		9·3	21·5	13·3	2 (worn)	2·546	2·388
	102	„		7·8	16·4	11·3		1·464	2·414
	109†	„		10·2	37·3	13·4		5·740	2·408†
	110†	Teardrop tail		7·0	28·0	6·7		1·219	2·403†
	113	Teardrop		16·2	32·0	16·4		8·886	2·423
	114	„		13·6	28·8	15·5		6·132	2·407
	123	„ (small)		6·0	15·0	10·0		0·821	2·409
	127	„		12·4	21·2	13·6		4·132	2·406
	134	„ (slender)		5·5	19·8	9·3		1·324	2·398
	135	„ (small)		7·5	15·1	10·8		1·134	2·358
	136	„ (small)		6·1	15·2	10·7		1·030	2·413
	137	„		7·6	18·2	12·3	1·8 (worn)	1·471	2·393
		Range		5·5 to 16·2	15·0 to 37·3	6·7 to 16·4		0·821 to 8·886	2·348 to 2·423
		Average		10·0	22·5	12·5		3·042	2·395
2 Teardrop cores (1·3%)	147	Teardrop core		19·0	23·2	20·5		8·651	2·411
	148	„ „		15·0	16·3	16·8		4·636	2·371
		Range		15·0 to 19·0	16·3 to 23·2	16·8 to 20·5		4·636 to 8·651	2·371 to 2·411
		Average		17·0	19·8	18·7		6·644	2·391
	TOTALS	Range	12·6 to 36·5	2·5 to 28·4	9·3 to 49·0	6·7 to 44·5	1·5 to 2·6	0·314 to 72·349	2·348 to 2·437
		Average	22·0	12·1	25·3	15·2		7·817	2·405

[1] ( ) one value only.
( ) not included in average
G = gibbosity.
W = waist region.
Where two values are given for G, this means unequal gibbosities.
* The only one with marked differences in size of the two gibbosities.
† Combined for purposes of calculating averages.
(Weights and specific gravities determined by T. H. Donnelly, Nov., 1964.)

TABLE 2

Showing average values and range in values of dimensions, weights and specific gravities of 148 australites from Morgan, S.A.

Shape Type	No. of Specimens	Percent of Population		Diameter (mm)		Depth (mm)		Length (mm)		Width (mm)		Flange Width (mm)		Weight (gms)		Specific Gravity
Flanged buttons	3	2·0	R	12·6 to 20·2	R	6·0 to 9·0	R		R		R		R	1·027 to 3·349	R	2·389 to 2·410
			A	15·9	A	7·2	A		A		A	(2·6)	A	1·988	A	2·401
Hollow button (broken)	1	0·7	R		R		R		R		R		R		R	
			A	22·5	A	10·6 (broken)	A		A		A		A	4·045	A	2·411
Lenses	2	1·3	R	16·4 to 16·9	R	7·4 to 8·2	R		R		R		R	2·212 to 2·275	R	2·392 to 2·400
			A	16·7	A	7·8	A		A		A		A	2·234	A	2·396
Round cores	44	29·7	R	15·0 to 36·5	R	10·0 to 27·8	R		R		R		R	2·580 to 41·831	R	2·369 to 2·436
			A	22·6	A	16·5	A		A		A		A	12·041 (43 spp.)	A	2·408
Ovals	16	10·8	R		R	3·2 to 18·5	R	9·3 to 39·3	R	8·2 to 31·9	R		R	0·314 to 28·808	R	2·380 to 2·429
			A		A	11·7	A	23·3	A	18·3	A		A	7·931	A	2·406
Oval cores	17	11·5	R		R	7·9 to 28·4	R	16·8 to 46·4	R	13·9 to 44·5	R		R	2·550 to 72·349	R	2·370 to 2·427
			A		A	14·5	A	24·2	A	20·8	A		A	12·556	A	2·404

TABLE 2—*continued*

Shape Type	No. of Specimens	Percent of Population		Diameter (mm)		Depth (mm)		Length (mm)		Width (mm)		Flange Width (mm)		Weight (gms)		Specific Gravity
Boats	18	12·2	R		R	5·0 to 13·8	R	15·1 to 39·2	R	8·9 to 19·0	R		R	0·772 to 12·236	R	2·379 to 2·431
			A		A	7·0	A	23·1	A	13·3	A	(2·3)	A	3·233	A	2·395
Boat cores	7	4·7	R		R	8·9 to 15·7	R	22·0 to 39·7	R	11·7 to 19·9	R		R	3·415 to 9·557	R	2·376 to 2·429
			A		A	11·2	A	30·4	A	16·0	A		A	6·137	A	2·397
Canoe	1	0·7	R		R		R		R		R		R		R	
			A		A	(7·8)	A	(22·8)	A	11·4	A		A	2·040	A	2·437
Dumbbells	11	7·5	R		R	5·0 to 9·3 (gibbosity) 2·5 to 7·7 (waist)	R	21·0 to 40·2	R	8·2 to 12·5 (gibbosity) 6·0 to 11·1 (waist)	R		R	1·182 to 4·341	R	2·370 to 2·422
			A		A	6·8 (gibbosity) 5·3 (waist)	A	31·2	A	10·6 (gibbosity) 8·5 (waist)	A	(1·5)	A	2·901	A	2·399
Dumbbell cores	4	2·7	R		R	7·9 to 12·8 (gibbosity) 7·2 to 11·4 (waist)	R	36·1 to 49	R	12·2 to 15·2 (gibbosity) 10·8 to 14·0 (waist)	R		R	5·414 to 13·644	R	2·388 to 2·435
			A		A	10·0 (gibbosity) 8·8 (waist)	A	43·7	A	13·5 (gibbosity) 12·0 (waist)	A		A	8·450	A	2·407

TABLE 2—*continued*

Shape Type	No. of Specimens	Percent of Population		Diameter (mm)		Depth (mm)		Length (mm)		Width (mm)		Flange Width (mm)		Weight (gms)		Specific Gravity
"Pea-nut"-like dumb-bells	5	3·4	R		R	8·1 to 11·3	R	28·5 to 39·7	R	9·7 to 12·6	R		R	3·147 to 8·223	R	2·374 to 2·434
			A		A	10·3	A	34·5	A	11·8	A		A	6·053	A	2·400
Oval "nut-like" form	1	0·7	R		R		R		R		R		R		R	
			A		A	12·2	A	22 0	A	13·4	A		A	4·809	A	2·411
Teardrops	16	10·8	R		R	5·5 to 16·2	R	15·0 to 37·3	R	6·7 to 16·4	R		R	0·821 to 8·886	R	2·348 to 2·423
			A		A	10·0	A	22·5	A	12·5	A	(1·8 worn)	A	3·042	A	2·395
Teardrop cores	2	1·3	R		R	15·0 to 19·0	R	16·3 to 23·2	R	16·8	R	to 20·5	R	4·636 to 8·651	R	2·371 to 2·411
			A		A	17·0	A	19·8	A	18·7	A		A	6·644	A	2·391
TOTALS	148	100	R	12·6 to 36·5	R	2·5 to 28·4	R	9·3 to 49·0	R	6·7 to 44·5	R	1·5 to 2·6	R	0·314 to 72·349	R	2·348 to 2·437
			A	22·0	A	12·1	A	25·1	A	15·2	A	2·1	A	7·817	A	2·405

R = Range in values. A = Arithmetic mean. Round forms = 50%, elongated forms = 50%.

are statistically significant, comparison between the percentages of shape types represented in each area shows certain marked differences (Table 3). 'Classifiable' means specimens other than nondescript fragments and fragments for which the original shape type is rather uncertain.

TABLE 3

Comparison of percentages of different shape types of australites from (a) near Morgan, (b) Florieton, and (c) Mulka, S.A.

	Shape type	Percentage of shape types		
		(a) 16 miles NNE. of Morgan (%)	(b) Florieton* (%)	(c) Mulka† (%)
Round forms	Flanged buttons and/or buttons with flange remnants	2·0	0·4	10·0
	Hollow forms (broken and unbroken)	0·7	0·0	1·9
	Button cores, lenses and larger round scores	31·0	64·9	27·8
	Spherical forms		0·7	
Elongated forms	Ovals and oval cores	23·0	9·0	21·1
	Boats and boat cores	16·9	12·4	23·0
	Canoes	0·7	2·1	1·1
	Dumbbells and dumbbell cores	13·6	3·1	10·3
	Teardrops and pear-shaped forms	12·1	6·2	4·8
	Club-shaped forms		0·1	
	Cylindrical forms		1·1	
	TOTAL	100·0	100·0	100·0
	Number of specimens	148	812‡	261§

* Generalized from Mawson's (1958) list of shape types.
† Generalized from Baker's (in press) list of shape types.
‡ Total number collected was 1475 specimens, but 663 of these are only fragments of australites and not classifiable into specific shape groups.
§ Total number investigated in detail was 275 specimens, but 14 of these are fragments of australites (a total of 689 specimens were inspected in five different collections of australites from Mulka (Baker, in press)).

As for other concentration centres in the vast australite strewnfield, there is no apparent reason why the Morgan and Florieton areas, which are only some twenty miles apart, show such significantly different proportions of the more common of the shape types which constitute the bulk of the australite populations. Taken over the two million square mile strewnfield as a whole, round forms tend to be 1½ to 3 times as abundant as elongated forms, as shown in Table 4.

TABLE 4

Ratios of round to elongated forms of australites from various concentration centres in the Australian strewnfield

Concentration centre (or region)	Ratios of the main australite shape types (Round/elongated)
Nirranda, Victoria	3/1
Charlotte Waters, Central Australia	2·49/1 [a]
Port Campbell, Victoria	2·4/1
Florieton, South Australia	1·94/1
Nullarbor Plain, S.A.-W.A.	1·83/1 [a]
Moonlight Head, Victoria	1·83/1 [a]
Kanagulk-Telangatuk East-Toolondo, Victoria	1·81/1 [c]
Harrow, Victoria	1·43/1 [d]
Nurrabiel, Victoria	1·33/1 [b]
Mulka, South Australia	0·51/1
Morgan, South Australia	0·5/1

[a] Calculated from Baker's tables (1956).
[b] From Baker (1964).
[c] From Baker (1959b).
[d] From Baker (1955).

Apart from variations in the percentages of the various shape types from Morgan to Florieton, and from these areas to Mulka, as shown in Table 3, there are also considerable variations between the overall percentages of round forms to elongated forms as shown in Table 5.

TABLE 5

Variations in populations, specific gravity values, and weights of australites from (a) near Morgan, (b) Florieton, and (c) Mulka, S.A.

	(a) Morgan		(b) Florieton		(c) Mulka*	
	Round forms	Elongated forms	Round forms	Elongated forms	Round forms	Elongated forms
Number of specimens	50	98	536	276	107	168
Percentage of total number	34%	66%	66%	34%	39%	61%
Average weight in grams	10·90	6·19	3·87	3·62	3·53	4·50
Average specific gravity	2·407	2·400	(–)	(–)	2·434	2·427

(–) no specific gravity determinations listed in Mawson's (1958) paper.
* from Baker (in press) – the obviously hollow specimens have been excluded from the calculations of specific gravity.

There are also marked differences in the weight ranges and average weight values as between the various shape groups represented in each of the Morgan and Florieton areas (Table 6).

TABLE 6

Comparison of weight ranges and average weight values of different shape groups of australites from near Morgan and from Florieton, S.A.

	Shape type	Morgan, S.A.		Florieton, S.A.	
		Range in weight (gms)	Average weight (gms)	Range in weight (gms)	Average weight (gms)
Round forms	Flanged buttons	1·03 to 3·35	1·29	1·94 to 3·01	2·51
	Hollow button (broken)		4·05		
	Lenses	2·12 to 2·28	2·23	0·18 to 5·92	1·40
	Round cores	2·58 to 41·83	12·04	1·01 to 12·02	5·31
	Spherical forms			8·91 to 9·90	8·84
Elongated forms	Ovals	0·31 to 28·81	7·93	0·60 to 21·26	6·93
	Oval cores	2·55 to 72·56	12·46	1·11 to 15·00	4·83
	Boats	0·77 to 12·24	3·23	0·27 to 15·35	2·86
	Boat cores	3·42 to 9·56	6·14		
	Canoes		2·04	0·50 to 6·69	2·73
	Dumbbells	1·18 to 4·34	2·90	0·76 to 4·05	2·61
	Dumbbell cores	5·41 to 13·64	8·45		
	"Peanut-like" forms	3·15 to 8·22	6·05		
	Teardrops & pear-shaped forms	0·82 to 8·89	3·04	0·30 to 8·40	2·07
	Teardrop cores	4·64 to 8·65	6·64		
	Club-shaped forms				7·80
	Cylindrical forms			2·39 to 14·78	6·72
Overall weight range		0·314 to 72·349		0·18 to 21·26	
Overall average weight			7·817		3·784
Total weight		1,156·855		3,073	

Table 6 reveals that round cores, ovals, oval cores, dumbbell- and teardrop-shaped groups each have a greater weight range and significantly higher average weight from the area 16 miles NNE. of Morgan than from Florieton. Flanged buttons have a higher average weight from Florieton than from near Morgan, but numbers in this shape group are low at each locality and not statistically significant. Lenses have a higher average weight from near Morgan, although heavier-weight and lighter-weight individual specimens of lenticular side aspect occur at Florieton. However, numbers are not statistically significant for lenses from near Morgan, whereas they are for lenses from Florieton. Forms that are boat-shaped in plan aspect have a greater weight range from the Florieton area, but a greater average weight from 16 miles NNE. of Morgan, and there are statistically significant numbers of specimens in this shape group for both areas.

Overall, the australites are heavier from near Morgan than from Florieton in virtually all of the different shape groupings, and the degree of weathering is not significantly different for the specimens from these two close concentration centres. The Florieton specimens (812 classifiable into specific shape types among a total of 1475 finds) have a total weight of approximately 3073 gms as calculated from Mawson's table (1958, p. 163) showing the weights of specimens in the separate shape groups. This is 2·66 times greater than the total weight (1157 gms) of

specimens constituting the Thamm collection from Morgan, and the weight range of 0·18 gms to 21·26 gms is significantly lower than from Morgan, while the average weight of 3·784 gms is 2·06 times lower than for the Morgan specimens. With a weight range of 0·46 gms to 22·7 gms and an average weight of 4·1 gms, the Mulka specimens fall between those from near Morgan and from Florieton respectively. The 275 specimens described from Mulka have a total weight of 1136 gms (Baker, in press), but this figure is reduced to 1091 gms when the weight of the 14 fragments present is deducted.

Specific gravity values were not given for the Florieton specimens described by Mawson (1958), hence no average specific gravity can be cited for comparison with the average specific gravity of 2·405 for the australites from near Morgan. The average specific gravity (2·405) for the 148 specimens from Morgan is significantly lower than that (2·430) from Mulka, 390 miles away WNW. of Morgan (Baker, in press).

Sculpture patterns and structures of australites near Morgan, S.A.

Like most australites recovered from the semi-arid to arid regions, the sculpture patterns of the australites from 16 miles NNE. of Morgan are dominated by the effects of terrestrial weathering. All specimens are relatively strongly abraded, occasionally some are fractured, while some are pitted and etched on all surfaces including fracture surfaces. Abrasion has resulted largely from physical erosion by wind-borne, dried sandy soils. Pitting and etching have resulted largely from chemical erosion by soil etchants during wetter periods of the geologically recent past and the rather infrequent rainy seasons of the present. In general, the etching is an earlier event in the process of terrestrial erosion and occurs in soils. Abrasion is mainly a later development after release of the tektites by soil deflation. Specimens swept or gravitated into recent sedimentary horizons (e.g. as in clay pans) may be subjected to further solution etching after various degrees of abrasion have occurred.

The worn character of all of the specimens is such that although most shape types are still recognizable, there is generally little or nothing preserved of the aerodynamical sculpture pattern. Few flow ridges of the ring wave pattern that was produced during the later stages of high velocity flight are still evident, and these are invariably rather indistinct, worn-down stumps of the original flow ridges (see Table 7 for specimens with some remnants of the ring wave pattern).

Very few specimens still retain the circumferential flange structure (Pl. 9, fig. 1) or remnants thereof (Pl. 11, fig. 19), and many have been so exfoliated on their front surfaces and/or around their perimeters that the sub-surface, strained, aerodynamically heated zone of the anterior surface region (Baker, 1963) has been spalled away to different degrees, sometimes completely or nearly so where the remnant conical core types of specimens are concerned (e.g. Pl. 10, fig. 26), and where flaked equatorial zones are prominently present around the peripheries of the specimens (e.g. Pl. 11, fig. 6). Flow swirls are occasionally evident on the posterior surface of some of these australites (Table 7) and when present are only poorly preserved or very indistinct (Pl. 9, fig. 45; Pl. 10, fig. 1-3).

One effect of the relatively advanced degree of terrestrial erosion is that the weights of the specimens as recorded in Table 1 are inevitably much lower values than the landing weights and the average weights given in Table 2 are thus minimal values. Specimens with sizable internal bubble cavities have had the outer walls of parts of the bubbles penetrated and removed by erosion, leaving relatively deep crater-like depressions with dulled and eroded walls (e.g. Pl. 9, fig. 3; Pl. 10, fig. 6,

TABLE 7

Surface Features of 148 australites from Morgan, S.A.

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
1	Oval core	II, 2	10·8		1-5·4 mm across 3·1 mm deep on posterior surface	one— 22·1 mm × 26·2 mm	Sub-vitreous lustre from natural solution etch polishing
2	Round core	III, 1	10·9			Indistinct on posterior surface	Smoothed and dulled by abrasion
3	Oval core	II, 1	12·4				Smoothed and dulled by abrasion
4	Round core	III, 2	11				Etch pits and vague flow lines on all surfaces, best on posterior surface
5	,, ,,	III, 3	10·5		4·2 × 3·3 mm on anterior surface— 0·6 mm deep	Fold-like flow lines on posterior surface	? small gas blister on posterior surface
6	,, ,,	III, 5	9·9				Vitreous recent fracture surface at one side of posterior surface
7	Oval core	II, 3	8			One—17 × 22 mm on posterior surface	Old, lightly etched fracture from anterior surface
8	Round core	I, 38	11·4				Flow lines reasonably well revealed
9	,, ,,	I, 43	10·9				Etch pits and 'orange-peel' effect
10	,, ,,	I, 42	8·8				Fold-like flow line pattern and some etch pits

Plates I-IV in Table 7 = Plates 9-12 elsewhere.

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
11	Round core	I, 41	8·3				Anterior surface smoothed by abrasion; posterior surface with central etch pit pattern
12	,, ,,	I, 39	9·8				Part of former rim preserved, mostly = flaked equatorial zone
13	,, ,,	I, 36	8·2				Flaked equatorial zone unequally developed; few pits, some flow lines
14	,, ,,	I, 37	8·2				Fold-like flow lines, some etch pits, side aspect approaching conical (1-13 above, the side aspect = bung-like)
15	,, ,,	I, 26	9·9				Abraded smooth on most surfaces
16	,, ,,	I, 35	9·8				Some etch pits; parts abraded smooth; side aspect approaching conical
17	,, ,,	I, 40	8·7				Fold-like flow lines; some etch pits
18	,, ,,	I, 22	11·7				Old, dulled conchoidal fracture to one edge of posterior surface
19	,, ,,	I, 27	9·2				Smoothed; plus some etch pits
20	,, ,,	I, 31	8·6				Smoothed; plus some etch pits and a few flow lines
21	,, ,,	I, 29	8·4		one; = 0·34 mm diameter; 0·17 mm deep		Small etch pits; several bubble pits 0·5 to 2·5 mm diameter on both surfaces are up to 0·02 mm deep

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
22	Round core	I, 25	9·5				Etched 'collisional bruise' pits on both surfaces
23	„ „	I, 23	8·5			16 mm across on posterior surface (worn)	Round core slightly fractured on one side. Smoothed posterior surface
24	„ „	I, 32	7·8				Flow lines and some etch pits
25	„ „	I, 30	7·5				Etch pits and grooves; plus a few flow lines
26	„ „	I, 33	7·2				Abraded, few pits; conchoidal fracture surface at one edge of posterior surface
27	„ „	I, 34	6·0				Abraded, few pits and flow lines
28	„ „	I, 18	7·3				Abraded, few pits
29	„ „	I, 28	8·7			Indistinct on posterior surface	Conical core; worn; flow lines and etch pits
30	„ „	I, 24	12·8				Worn; fine etch pits and few flow lines
31	„ „	I, 16	6·4		one = 0·37 mm on f.e.z.* (unusual feature) 0·2 mm deep		Abraded; few flow lines and etch pits. Ant. surf.† approaching flatness
32	„ „	I, 19	11·2				Abraded conical core with flaked equatorial zone indistinct. Etch pits and flow lines
33	„ „	I, 15	11·0				Posterior surface almost flat (from erosion?)
34	Oval core	II, 21	6·9				Some etched flow lines and pits
35	Round core	I, 21	7·9				Complex, fold-like pattern of flow lines on posterior surface; etched

* f.e.z. = flaked equatorial zone. † Ant. surf. = anterior surface.

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
36	Round core	I, 20	6·8				Complex, fold-like pattern of flow lines on posterior surface and some on anterior surface; etched
37	,, ,,	I, 11	8·6				Abraded to a degree after previous natural solution etching
38	,, ,,	I, 17	5·6				Smoothed by abrasion, few small etch pits
39	,, ,,	I, 12	7·0				A few bubble pits and etch pits, lesser flow lines
40	,, ,,	I, 9	5·2				Smoothed by abrasion, posterior surface with some deeply etched flow lines
41	,, ,,	I, 10	5·8				Smoothed by abrasion, posterior surface with pits and a few flow lines
42	,, ,,	I, 13	6·7				Abraded conical core; pits and few etched flow lines on posterior surface
43	,, ,,	I, 14					Conical core abraded; fine etch pitting, few flow lines, ? 'collisional bruises'
44	,, ,,	I, 46	12·7				Smoothed by abrasion; fine etch pits, few flow lines
45	,, ,,	III, 4	10·4				Fold-like pattern of flow lines on posterior surface; etch pits of varying size and pattern
46	,, ,,	I, 45	9·5			22·3 mm across on posterior surface	Also other flow lines in fold-like patterns on posterior surface; flow lines on anterior surface; etch pits on both

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
47	Round core	I, 44	9·0				Flaked equatorial zone indistinct towards anterior surface. Collisional bruise marks; few flow lines; abraded after natural etching
48	Broad oval	II, 4	7·9			One = 20·3 × 15·7 mm on posterior surface	Flow lines, etch pits and etch grooves
49	,, ,,	II, 5	9·0				Complex fold-like pattern of flow lines, etch pits and etch grooves common
50	Oval	II, 7	7·8				Some flow lines, etch pits and etch grooves
51	,,	II, 6	7·8				Abraded after etch pitting and etch grooving naturally. Small conchoidal fracture (old) at one end
52	,,	II, 8	7·3			One = 15·3 × 15·9 mm on posterior surface	Other flow lines and etch pits on all surfaces
53	,,	II, 11	7·0				Fracture fragment removed from one side; complex flow lines and pits
54	Broad oval	II, 12	6·5				Flaked equatorial zone indistinct. Smoothed by abrasion. A few flow lines, etch pits and exposed internal bubbles
55	Boat core	III, 9	6·2			One = 13·0 × 6·6 mm on posterior surface	Flaked equatorial zone indistinct. Smoothed by abrasion and etching. Fine flow lines and etch pits
56	,, ,,	III, 13	5·7				Flaked equatorial zone indistinct. Few flow lines, several etch pits; generally smoothed by abrasion

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
57	Oval	II, 15	5·7				Finely etch-pitted on all surfaces. Very few flow lines in evidence
58	Boat core	III, 10	5·3			One = 7·2 × 3·6 mm on posterior surface	Flaked equatorial zone indistinct on one side. Complex fold-like flow lines on posterior surface. Etch pits and areas smoothed by abrasion
59	Oval	II, 14	7·9				Complex fold-like pattern of fine flow lines and few etch pits. One exposed internal bubble = 0·14 mm across, 0·03 mm deep
60	Dumbbell	IV, 4	Rim present	worn away			Smoothed by abrasion. Fine etch pits; longitudinal flow lines on anterior surface
61	,,	IV, 6	,, ,,	,, ,,	5·5 across 0·9 deep on posterior surface 3·9 across 0·9 deep on anterior surface		A few flow lines and etch pits
62	,,	IV, 5	Flange remnants 1·5 mm wide	Faint remnants on waist			Etch polish and longitudinal flow lines; few etch pits
63	,,	IV, 11	Minute flange remnants	Vaguely concentric remnants			Smoothed by abrasion; few remnants of former etch pits and flow lines
64	,,	IV, 8	Rim present	worn away			One end conchoidally chipped. Longitudinal flow lines

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
65	Dumbbell	IV, 9	Rim present	worn remnants on waist			Longitudinal flow lines on posterior surface and some on anterior surface. Some etch pits
66	Dumbbell core	IV, 3	6·8 on gibbosities				Smoothed by abrasion; few etch pits and flow lines
67	,, ,,	IV, 1	8·0 on gibbosities				Smoothed by abrasion; few etch pits and flow lines; occasional lunate collisional bruise-marks
68	,, ,,	IV, 7	6·5				Smoothed by abrasion; finely etch-pitted; few flow lines on anterior surface
69	Boat	III, 18	Minute remnants of flange base	worn concentric			Longitudinal, somewhat contorted flow lines; two exposed internal bubbles on anterior surface 0·23 mm across and 0·17 mm across
70	,,	III, 29	rim present	worn away			Finely etch-pitted with few flow lines
71	,,	III, 22					Finely etch-pitted; few flow lines. Posterior surface flat (slightly concave to the feel but scarcely visible)
72	,,	III, 25	Minute flange remnant on one side	worn, vague, ? concentric			Etch-pitted and etch-grooved; few flow lines
73	,,	III, 27	Rim present	worn, vague ridges			Abraded; remnants of longitudinal flow lines, few etch pits. Small conchoidal chip from one edge near exposed small internal bubble 0·17 mm across

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
74	Boat (Canoe-like appearance in one aspect)	III, 28	,, ,,				Ends taper; longitudinal flow lines
75	Boat	III, 30	,, ,,				Etch pits and longitudinal flow lines. Facets at one end due to chipping (followed by etch-pitting)
76	,,	III, 26	,, ,,				Smoothed by abrasion. Originally could have been a canoe, but too worn for certainty
77	,,	III, 31	minute, thin flange remnants	clockwise spiral; worn			Contorted flow-lines on posterior surface; a few etch pits are very minute
78	Dumbbell core	IV, 2	4/8 on one gibbosity				Visually dumbbell-shaped in side aspect only. Complex flow-line pattern on posterior surface, few pits
79	Boat	III, 11					Finely etch-pitted and partially smoothed by abrasion
80	,,	III, 16		worn away			Complex, fold-like flow pattern on posterior surface with long axes parallel to long axis of form. Also on anterior surface. Etch pits and grooves on both surfaces

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
81	Boat core	III, 15	6·9				Abraded; smooth flaked equatorial zone and anterior surface. Remnant etch pit pattern on posterior surface. Conical in end-on aspect
82	„ „	III, 14	Minute remnants of flange along sides	Vague remnants concentric			Few flow lines and etch pits on both surfaces. Anterior surface mainly smooth
83	Boat	III, 17	Rim present, flange stumps showing in spots	Vague remnants wavy from interference in equatorial regions			Flow lines and few etch pits on both surfaces
84	Oval core	II, 13	7				Flow lines and few etch pits on both surfaces
85	Boat core	III, 23	7·1				Conical in end-on aspect. Smoothed by abrasion; few etch pits
86	Boat	III, 20	Rare stumps of former flange left	Clockwise ridges perceptible			Posterior surface pitted with few flow lines. Anterior surface smoother with much finer etch pits
87	Oval	II, 17	Remnants of flange stumps around edges	7 closely spaced, concentric, worn		0·2 × 0·1 mm to 7·5 × 6·3 mm on posterior surface	Smooth, plus fine flow lines, very rare pits; several 'saw-cuts' = etch grooves 0·3 mm wide. Concave etched fracture surface at one end
88	„	II, 18	„ „	Indistinct remnants	Two as figure 8 5 mm × 3·2 mm, 1·2 mm deep		Complex fold-like pattern of flow lines on both surfaces

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
89	Boat	III, 21					Smoothed by abrasion, finely pitted (worn down etch pits and abrasion pits)
90	,,	III, 7	Rim present, rounded by wear				Very complex flow-line pattern on both surfaces; few etch pits and grooves
91	'Peanut' type (rounded ends)	IV, 18			One = 3·7 × 1·7 mm other = 3·7 × 2·7		Waist-like region = 10·4 × 10·8 mm thick. Surface with some pits and 'collisional bruise-marks'
92	,,	IV, 17	5·3 (very worn)				Thinner end = 10·9 × 10·2 mm. Few flow lines tend to be longitudinal. Several pits = ? exposed internal bubbles (no slight constriction in waist)
93	,,	IV, 19	4·0 (indistinct)				Abraded smooth with remnants of pits showing. No perceptible constriction of 'waist'
94	'Peanut' type (pointed ends)	IV, 20		Worn longitudinal ridges converge to pointed ends			Longitudinal to fold-like flow lines, few pits and 'collisional bruise-marks'
95	Oval 'Nut-like' form	IV, 21					Fold-like flow lines and occasional etch pits and short grooves
96	Boat core	III, 8	5·6 (indistinct)				Smoothed by abrasion; few poorly marked flow lines showing, but several pits (etch pits and ? exposed internal bubbles)

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
97	Teardrop	IV, 28	4·1 to 1·3 mm deep				Longitudinal flow lines constricting into tapered end. Tail of tear broken off and end worn
98	,,	IV, 27	Rim present 5·0 on gibbosity‡				Pit 0·15 mm across and 0·2 mm deep on anterior surface. Smoothed by abrasion, few pits and flow lines, rare small grooves evident
99	,, (lustrous from etching)	IV, 29	Rim present	Vague remnants of concentric ridges		8·2 × 6·2 mm on posterior surface	Flow lines in tail crowd into the attenuation. Radial star-like (12 rays) pattern of etch grooves in centre of posterior surface of gibbosity
100	,,	IV, 30	4·7 on gibbosity‡		6·1 mm across on posterior surface and 4·9 mm deep		Smoothed by abrasion; flow lines occasionally worn, trend into the attenuation. Few pits from earlier etching process
101	,,	IV, 31	Flange remnant 2 mm wide at end of gibbosity	Fairly clear concentric, wrinkled on gibbosity			Parts of flow ridges tend to show spiral clockwise trend. Partly smoothed by abrasion; few etch grooves and pits
102	,,	IV, 35	Rim present				Smoothed by abrasion; few flow lines and occasional pits (etch pits and exposed small bubbles)

‡ F.e.z. at broad end of gibbosity → surface worn and may be original structural feature rather than a f.e.z. caused by later weathering on earth's surface. (F.e.z. = flaked equatorial zone.)

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery; depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
103	Dumbbell (approach-'Peanut' type with pointed ends)	IV, 12	,, ,,	Very vague remnants	Etched-out crater = 6·1 × 4·5 mm, and 0·1 mm deep		Smoothed by abrasion; few flow lines trend to pointed ends. Few pits; some flow lines overdeepened and groove-like
104	Dumbbell (slightly distorted)	IV, 10			4·4 mm × 3·8 mm, and 0·07 mm deep on anterior surface		Complex pattern of fold-like flow lines on both surfaces, also a few pits (etch pits and exposed small bubbles)
105	Dumbbell	IV, 13	Worn rim present	Vague concentric			Anterior surface evenly curved without waist depression occurring; smoothed by abrasion. Flow lines not distinguishable. Fine etch pits and few bubble pits.
106	,,	IV, 15	,,				Smoothed by abrasion; waist depression scarcely perceptible on anterior surface. Fine etch pits and few flow lines
107	,,	IV, 14	Worn rim present and small stump of flange				Smoothed by abrasion; remnant etch pits and rare flow lines showing. Waist depression imperceptible on anterior surface
108	,,	IV, 16	Worn rim present				Complex pattern of twisted flow lines trending generally length-wise. No waist depression evident on anterior surface

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery, depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
109	Long teardrop	IV, 26	2·7 to 4·6 deep	Worn away			Tail (probably similar to No. 110) broken off. Attenuated end slightly recurved—smoothed by abrasion; a few longitudinal flow lines; few pits
110	Long tail of large teardrop		Rim relatively sharp				Longitudinal tapering flow lines well-defined; few etch pits. Fractured end as etched as other surfaces
111	Flanged button (1/11 of flange missing)	I, 1 and 2		Worn, but discernible as anticlockwise spiral	Worn exposed internal pit on anterior surface		Radial flow lines on anterior surface. Etch pits and, across diameter, flow lines on posterior surface of core. Dull etch varnish; etch pits on flanges
112	Worn, broken, hollow button	I, 3 and 4	Worn stumps of flange band left	Worn, but irregularly anticlockwise spiral	Worn opening of cavity 13·8 mm across	Remnants of swirl 16 mm across on posterior surface	Cavity approximately 15 mm diameter, worn through on posterior surface thinner wall. Cavity wall flow lined and etch-pitted; Radial to complex flow lines on anterior surface
113	Teardrop	IV, 22	3 small facets in end-on view of gibbosity = probably fracture facets				Approximately circular in end-on aspect—smoothed by abrasion; few etch pits, twisted flow lines not plainly shown. Tail end fractured and rounded
114	„	IV, 23					Tail end fractured and worn. Sculpture pattern = mainly etch pits and bubble pits up to 2·0 mm across

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery, depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
115	Boat with flange remnants	III, 19	Flange (thin, broken)	Few, worn, concentric		8·0 × 5·2 mm on posterior surface	Complex fold-like flow line pattern on both surfaces; few etch pits
116	Lens (probably originally a button)	I, 5	Rim present (worn)	Anticlockwise spiral (worn)			Across diameter, flow lines on posterior surface and on anterior surface; few etch pits
117	Button with 2 minute remnants of flange stump	I, 7		Concentric (worn)			Flow lines and occasional etch pits on both surfaces
118	Small oval with irregular outline from erosion	II, 32					Form relatively flat, with few flow lines and fine etch pits
119	Button with very minute remnants of flange stumps	I, 8					Several etch pits and a few flow lines (some pits = possibly exposed bubbles up to 1·1 mm across)
120	Small oval with worn bubble crater	II, 34	Rim present (worn)		6 mm across, 0·5 mm deep on posterior surface		Few flow lines and minute etch pits
121	Small oval with small worn bubble crater	II, 31	,, ,,		3·5 mm across, 0·8 mm deep on posterior surface		Smoothed by abrasion, few remnant etch grooves and rare etch pits
122	Small oval ('pip-like')	II, 33					Smoothed by abrasion, few remnant etch grooves and rare etch pits

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery, depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
123	Small teardrop	IV, 37	Small remnant of thin flange	Worn away			Complex fold-like flow line pattern on gibbosity; flow lines trend into attenuated end. Shows high etch lustre
124	Oval conical core (Shape due to terrestrial erosion)	II, 28	7·0				Contorted flow-lines, some etch pits on posterior surface. Other surfaces smoother but finely etch-pitted
125	„ „	II, 24	5·5				Smoothed by abrasion; several etch pits and exposed bubbles as pits, but few flow lines evident
126	Eroded oval core	II, 23	6·1				Finely etch-pitted, somewhat abraded, few flow lines
127	Teardrop	IV, 32					Abraded, but with remnants of etch pits (worn) and flow lines from previous etching
128	Oval core (conical)	II, 29	7·0				Few flow lines; several pits (small etch pits and larger bubble pits up to 1·5 mm across and shallow)
129	Oval core	II, 20	5·6		One = 4·6 × 4·0 on fracture surface at one edge (1·0 mm deep)		Abraded, but with flow line, flow groove and etch pit remnants

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery, depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
130	„ „	II, 27	5·6				Smoothed by abrasion, but showing one or two remnant flow grooves, several etch pits and 'collisional bruisé marks'
131	Oval	II, 30	Small worn remnant of flange stump	Worn and vague but discernible as anti-clockwise spiral			Flow lines and etch pits on both surfaces
132	Canoe	III, 32	Worn, narrow zone (0·1 mm)	Longitudinal, worn, wrinkled in equatorial regions			Attenuated ends = 2·3 and 2·7 mm wide, but are broken. Complex flow line pattern on both surfaces, flow lines trend into the attenuations; few etch pits
133	Boat	III, 24	Worn rounded rim				Flow ridges and etch pits on posterior surface, etch pits on anterior surface
134	Slender teardrop	IV, 34	Rim present				Abraded; few remnant flow lines and etch pits. Attenuated end broken and worn; end of gibbosity with fracture facet
135	Small teardrop	IV, 36	Rim present and rare remnant stump of flange	Vague remnant around stagnation point is concentric			Complex, fold-like pattern of flow lines trend into attenuated end. Several fine etch pits on both surfaces

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery, depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
136	„ „	IV, 38	Worn rim present				Posterior surface nearly flat. Complex fold-like pattern of flow lines, some of which trend into attenuated end. A few etch pits. In part abraded
137	Teardrop	IV, 33	Flange remnant = 1·8 wide, but is worn	Worn, concentric around stagnation point			Complex pattern of flow lines, some of which twist across the attenuated end. Several etch pits and some flow lines over-deepened by etching
138	Lens	I, 6	Rim present	Worn, concentric			Complex, fold-like pattern of flow lines, on posterior surface, with few etch pits. Anterior surface with flow lines and etch pits and rare, minute höfchen and tischschen structures. 'Saw-mark' extends from pole to pole across anterior and posterior surfaces
139	Oval core	II, 19	9·0 (incomplete around form)				Flow lines; pits up to 2·3 mm across
140	Oval core (conical)	II, 9	9·3				Fine flow lines and etch pits
141	„ „	II, 10	14·1				Smoothed by abrasion; with few remnant etch pits and rare lunate 'chatter-marks'
142	„ „	II, 25, 26	14·5				Few flow lines and etch pits, mainly smoothed by abrasion

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery, depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
143	Oval core (conical)	II, 16	11·7		Round; 3·3 mm across and 1·2 mm deep on posterior surface	14·9 mm across on posterior surface	Flow lines, etch pits (some elongated)
144	„ „	II, 22	8·7				Few flow lines and etch pits; generally smoothed by abrasion
145	Broken round core	III, 6	12·8		Exposed internal cavity = round, 5 mm across		Abraded and smoothed most parts of outer and fracture surfaces. Few fine flow lines, occasional etch pits, a few lunate 'chatter-marks'
146	Broken boat core	III, 12	6.3 Worn, on one side only		Exposed internal cavity on fracture surface = 11·5 × 9·9 across (2 mm deep)		Smoothed by abrasion, but with remnant fine flow lines and small etch pits. Flow lines on fracture surface concentric with rim of cavity
147	Teardrop core	IV, 24	14·3 worn				Exposed internal bubble on f.e.z.§ = 2·2 mm across. Smoothed by abrasion; few remnant flow grooves worn and trend into tail. Few etch pits. 'Saw-marks' (= etch grooves) cross from distal edge of posterior surface to top end of f.e.z.§

§ Flaked equatorial zone.

TABLE 7—*continued*

Collection Number	Shape Type	Plate Number	Nature of periphery, depth of flaked equatorial zone where present (mm)	Flow ridges on anterior surface	Surficial bubble craters	Flow swirls on posterior surface	Remarks
148	Teardrop core	IV, 25	15·6				Abraded; few etch pits and flow lines, some of which twist into the attenuated tail end. 2 or 3 'navel' structures resemble 'höfchen' and 'tischschen' structures

Flaked equatorial zone depth measurements are average value for each form, i.e. these zones are not always the same depth all around the circumference of a particular specimen, the depth values varying from 0·5 mm to 1·0 mm each side of the average.

30). The cavity depth of the broken hollow button illustrated in Pl. 9, fig. 3 is 7·3 mm. Since the depth of the specimen is 10·6 mm from the front pole to the broken back surface, the thickness of the front wall in its present aerodynamically ablated and partially terrestrially eroded state is 3·3 mm. Originally it was probably at least twice this thickness before the onset of aerodynamic ablation of the primary hollow form. The thickness of the rear wall has been calculated from diagrammatically reconstructing the original form as being a little under 0·5 mm; this is very thin, hence its failure to resist terrestrial erosion and persist as a complete, unbroken hollow australite.

As gauged from the specific gravity values listed in Table 1, it becomes evident that none of the specimens contain unbroken internal bubbles of a size warranting their classification as true unbroken hollow forms. The lowest specific gravity of 2·348 is for a teardrop-shaped form (Table 1, 98, Pl. 12, fig. 27) in which one or two enclosed bubbles in the size range below 2 mm diameter may be responsible for lowering the specific gravity 0·057 below the average value. Alternatively, the specimen may contain a number of scattered, even smaller internal bubbles. Holding this teardrop-shaped specimen against a strong beam of light failed to reveal the internal translucency shown by hollow forms with distinctly lower specific gravity values.

Some specimens reveal surficial bubble craters 2·5 mm and over in diameter (Table 7). These sometimes occur on the posterior surface (e.g. Pl. 9, 29; Pl. 10, 2, 31; Pl. 12, 6), sometimes on the anterior surface (e.g. Pl. 11, 12). They are not as deep as in the more distinctly broken hollow forms (e.g. Pl. 9, 3; Pl. 12, 30), and apparently represent the sites of gas bubbles of intermediate size (approximately 2·5 mm-5·0 mm in diameter) that may have burst at the surface of the tektite during formation at the extraterrestrial birthplace. Terrestrial erosion has subsequently worn down and modified the rims and walls of these intermediate bubble depressions.

Smaller pits on the surfaces of several of the specimens (e.g. Pl. 9, 10, 12, 29, 35; Pl. 10, 3, 11, 19, 21; Pl. 11, 2, 3, 4, 8, 13; Pl. 12, 6, 17, 19, 23, 24) were probably largely produced by differential solution-etching during burial in moist soils. Embedded in some of these pits, also jammed in or sometimes partially cemented along a few of the solution etch grooves and etched-out schlieren, and occurring in parts of the few flange-core boundaries still extant, there occurred occasional light-brown to red and brownish lateritic constituents comparable with the soils in the region of discovery. The colour variation of these embedded terrestrial soil constituents arises from differential leaching of the natural rust components (ferric oxide and ferric hydroxide) from place to place. The soil particles lodged in certain of the deeper parts of the sculpture pattern of the australites are mostly the finer fractions of ferruginous clay material carrying occasional small, well-rounded detrital grains of quartz ranging up to 0·5 mm across. These constitute the adventitious materials that were removed on cleaning the australites preparatory to weighing and determination of the individual specific gravity values.

Collisional bruising of some of the specimens has produced incipiently-formed to more specifically defined chatter-marks of lunate to sub-circular outline on some of these worn australites (e.g. Pl. 10, fig. 4, left-hand side of photograph, and Pl. 11, fig. 2, top left portion of photograph), and these have been further weathered to different degrees. In these 'bruise-mark' structures occur small areas where very thin flakes are tending to lift up, and minor amounts of the ferruginous clay constituents of the soil have filtered in to form thin films under parts of the bruised

portions of the tektite glass. Evidently collisional bruising of some specimens has arisen fortuitously during limited distances of transportation of australites and other constituents of lag deposits across the deflated areas constituting the bare ground on which they were found. Smaller, less frequent collisional 'bruise-marks' may have resulted from the impact of smaller stones or granules washed against the australites during run-off of rainwater on local gently sloping parts of the surface where they were found.

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Explanation of Plates

PLATE 9

Fig. 1-46—Eroded round forms of australites from near Morgan, S.A. 1—posterior surface and 2—anterior surface of the same flanged australite button; 3—posterior surface and 4—anterior surface of the same broken hollow form (4 reveals worn remnants of flow ridges); 5-6—posterior surfaces of lens-shaped forms; 7-8—anterior surfaces of two different button cores from which the flange has been shed; remainder 9-46—posterior surfaces of worn, mainly smoothed round cores sometimes with small craters (29), chipped edges (33) and flow lines and etch pits (20, 43, 45). Photographs, natural size, by N. Philip.

PLATE 10

Fig. 1-34—Eroded oval forms of australites from near Morgan, S.A. 1, 3 reveal flow swirls; 2, 31 show surficial bubble craters while 34 possesses a large bubble crater on the posterior surface of a small form; 26 is an end-on view to show the conical core type of outline, with flaked equatorial zone showing on each side. Irregularity of outline in plan aspect of some forms (e.g. 16, 23, 25, 27, 28, 30) is due to erosion and fracture. Photographs, natural size, by N. Philip.

PLATE 11

Fig. 1-34—Eroded round forms (1-6), boat-shaped forms (7-31), and canoe-shaped form (32-34) of australites from near Morgan, S.A. 3, 4 reveal flow swirls; 9, 10, 27 show flow lines; 12 shows a large bubble crater (at top of photograph); 19 shows distinct flange remnants but 14, 17, 18 show only remnants of flange stumps and flange band; 6—side view of a broken form; 32—posterior surface; 33—side view, and 34—anterior surface of the same canoe-shaped form, with narrow flange (32) and remnants of flow ridges (33). Some of the boats are broader forms (e.g. 7), others are more slender for their length (e.g. 8, 26, 27). Unless otherwise stated, posterior surfaces are shown. Photographs, natural size, by N. Philip.

PLATE 12

Fig. 1-38—Eroded dumbbell-shaped forms (1-16), 'peanut-like' forms (17-20), oval 'nut-like' form (21), and teardrop-shaped to pear-shaped forms (22-38) from near Morgan, S.A. Nos. 2, 4, 5, 8, 25, 28 show poorly marked flow lines; 6, 30 show exposed internal bubble cavities; 26—side view of gibbosity of teardrop-shaped form and detached attenuated tail of a teardrop-shaped form (probably from two different but allied specimens); 31, 33 show small remnants of the flange at the broader end of the gibbosity; the constricted waist region of the dumbbell-shaped forms varies from broad and stout (e.g. 1, 2, 7) to narrow and slender (e.g. 5, 6); 11 reveals minute remnants of the flange structure in the waist regions; a star-shaped erosion sculpture pattern is shown by 29. Photographs, natural size, by N. Philip.